

## Chapter 2

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# The Causes, Extent and Consequences of Lake Drainage in the Olsztyn Lakeland in the 19<sup>th</sup> and Early 20<sup>th</sup> Century

### 1. Introduction

Lakes are short-lived landscape components that undergo dynamic changes over time, most of which result in the depletion of lake resources (Lossow 1996). The decrease in the surface area and volume of lakes could be a consequence of natural evolution, such as lake shallowing due to organic matter accumulation or aquatic vegetation overgrowth. In areas that are relatively free of anthropogenic pressure, those processes take a long time, but they can be rapidly accelerated when inflows from the catchment area become intensified (Birch, McCaskie 1999, Kajak 2001, Dokulil and Teubner 2003).

Shallow lakes are at much greater risk of the above than water bodies with a significant depth and volume (Skwierawski and Cymes 2004, Tan and Ozesmi 2006). The progressing drop in lake surface area may also result from human intervention in the hydrological regime, mainly through land improvement, drainage of swampy or seasonally submerged areas, water uptake for the needs of agriculture and industry, construction of canals and river regulation schemes (Okruszko 1969, Marszelewski 2005).

Small-scale water retention and the preservation of water quality are very important considerations in environmental protection and spatial management. Those goals are achieved through efforts which aim to restore former lakes and improve the condition of the existing water bodies. In the past, shallow lakes in north-eastern Poland were drained to create additional farmland (Srokowski 1930, Leyding 1959, Lossow 1996). Those measures were targeted mainly at shallow lakes which were easy to drain with minimal effort and cost.

This monograph discusses the reasons for and the causes of lake drainage, and it monitors quantitative changes in lake systems that took place in the Olsztyn Lakeland during 19<sup>th</sup> century land reclamation projects. Lakes were drained

in order to gain more farmland, and those processes significantly depleted the existing water resources.

## 2. Surveyed area – Olsztyn Lakeland

In this monograph, changes in the hydrological regime of lakes brought about by land reclamation projects were analyzed on the example of the Olsztyn Lakeland within the physiographic boundaries proposed by Kondracki (2000) (Fig. 1).

The Olsztyn Lakeland is the largest and the westernmost mesoregion of the Masurian Lakeland (Kondracki 1972, 2000). It occupies a total area of 3820 km<sup>2</sup>. In physiographic terms, the Olsztyn Lakeland is situated in the East Baltic Lakeland sub-province of the East Baltic Lowlands province. In the north, it borders the Orneta Plain, Górowo Heights and Sępopol Plain (along the Lidzbark Warmiński – Bisztynek line), it is adjacent to the Mrągowo Lakeland in the east (along the Biskupiec – Dźwierzuty axis), and in the south, it borders the Masurian Plain and Lubawa Hummock (the boundary intersects the towns of Waplewo and Jedwabno). In the west, the Olsztyn Lakeland borders the Iława Lakeland along the Ostróda – Morąg axis.

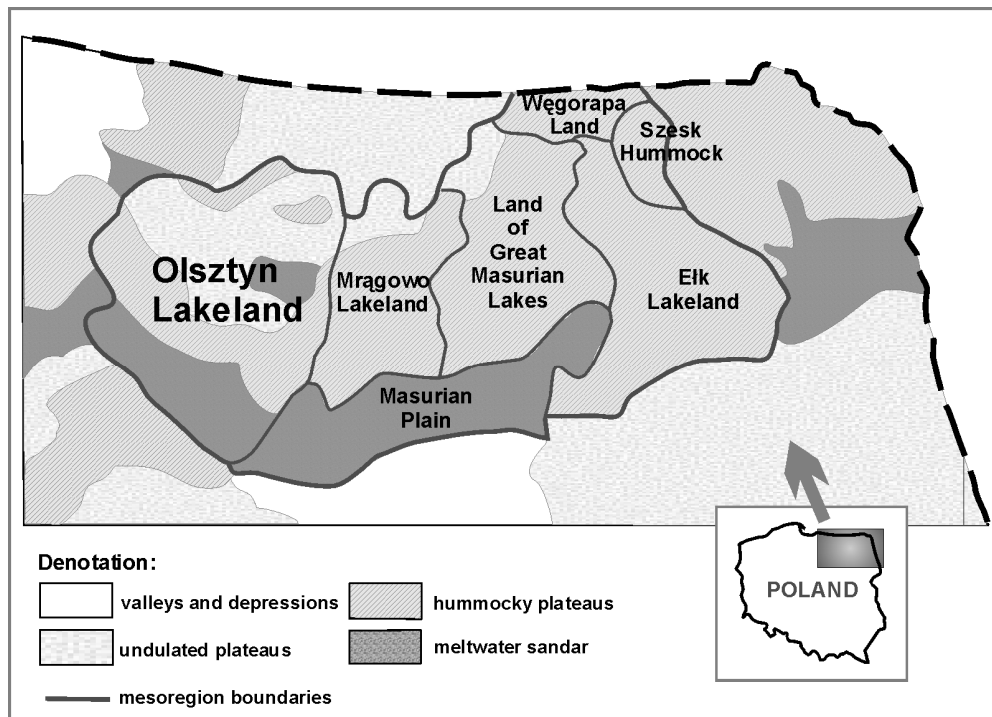


Fig. 1. Location of the Olsztyn Lakeland relative to the remaining mesoregions of the Masurian Lakeland (after Kondracki 2000)

In geomorphological terms, the Olsztyn Lakeland is characterized by significant landform diversity. In some areas, differences in height reach even several dozen meters (for example in the upper course of the Łyna river valley). Altitude is determined in the range of 100÷140 m above sea level, and it exceeds 200 m above sea level in terminal moraine formations. The latter comprise areas with a considerable slope, and according to Gotkiewicz and Smołucha (1996), around 20% of the Olsztyn Lakeland has an incline higher than 6%. The discussed region features distinctive post-glacial formations, such as terminal moraines comprising a latitudinal band of eight moraine ridges (formed during the first eight of the nine glacial retreat phases), ground moraine hills, glacial deposits such as eskers and kames, fluvoglacial plains – sandar, as well as permanent and seasonally flooded land depressions with no outlet.

A series of lakes stretching east-west in the Olsztyn Lakeland were formed during various glacial retreat phases. The discussed area has the highest number of lakes in all mesoregions of the Masurian Lakeland. According to Lossow (1996), the Olsztyn Lakeland features 300 lakes which have a total area of 154.2 km<sup>2</sup> and cover 4.04% of the region. The majority of large water bodies are found in the catchment area in the upper course of rivers Łyna and Pasłęka, south of Olsztyn. The largest lakes in the mesoregion are: Łańskie (area of 1070 ha), Dadaj (975 ha, the largest water body in the southern part of the Lakeland), Pluszne (868 ha), Wulpińskie (707 ha), Luterskie (688 ha), Košno (563 ha), Kalwa (561 ha) and Omulew (504 ha) (Choiński 1991).

The vast diversity of soils in the Olsztyn Lakeland attests to the region's history. In its southern part, soil cover was formed predominantly by glacial meltwater – the area of Nidzica and Szczytno constituted the southern glacial boundary. The above process created vast stretches of sandy soils and sandar. The central and northern parts of the region between Olsztynek and Lidzbark Warmiński have a predominance of medium-heavy loamy soils, locally intersected by lighter soils formed by glacial meltwater. Land depressions are occupied by lakes, peat grasslands and swampy remnants of former lakes. Forests occupy around 30% of the Olsztyn Lakeland's area, mostly in its southern part and along the valleys of rivers Łyna and Pasłęka (Kondracki 2000).

### **3. Economic growth and lake drainage in the 19<sup>th</sup> and early 20<sup>th</sup> century**

In the 19<sup>th</sup> century, lakes were drained or their surface area was reduced in order to gain more farmland. Meadows and pastures established in areas which were once covered by water were regarded as particularly valuable acquisitions. In published sources of the time, they were referred to as "most exquisite", "delightful" and "most fertile" grasslands (Sieniawski 1878, Barczewski 1918) (Phot. 1).



Phot. 1. Renaturalised lake near Sętal vilage; at the beginning of 20<sup>th</sup> century in this location were “delightful grasslands”, according to Barczewski (1918) (phot. by author)

According to economic and geographic papers published before World War II, the only significant role played by natural water bodies was fish production. Similar arguments were formulated as regards other aquatic ecosystems (peatlands, swamps, ponds), which were regarded as undesirable landforms and a hindrance to agricultural production (Srokowski 1930). Haffer (1860) recognized the scenic value of lakes and their importance for fish production (*"the lake is an eye through which the earth looks up into the skies, and the wanderer gazes at it with pleasure"* in original: „jezioro zdając się iż jest okiem, którym ziemia spogląda w niebo, a wędrowiec patrzy na nie z przyjemnością”), but he also remarked that water bodies were the cause of flooding in adjacent territories, that swampy areas were unfit for agricultural production and they obstructed land transport. In his opinion *"the inhabitants of waterlogged areas would undoubtedly benefit from dry fields and fertile soils rather than the monotonous expanse of water"* (in original: „bezwarunkowo jednak milej będzie dla mieszkańców nadbrzeżnych, mieć pola suche i grunty żyzne, zamiast monotonnej powierzchni wody”).

For these reasons, lake drainage became a popular practice in north-eastern Poland (East Prussia at the time) in the 19<sup>th</sup> century. Land reclamation schemes were implemented mostly in shallow lakes that supported the construction of standard drainage networks and the permanent evacuation of water from land basins.

In the past two centuries, the extent of human intervention in the hydrological regime was determined by the level of technological advancement, economic performance and, to a certain degree, the social situation in the region. The 19<sup>th</sup> century was a period of economic hardship in the history of the Masurian Lakeland. Beginning in the 1870s, the region suffered political and economic instability that led to a serious crisis and halted agricultural progress (Wakar 1971). At the beginning of the 19<sup>th</sup> century, the Napoleonic wars wrought significant damage to East Prussia. In 1807, after several months of armed conflict, farmland in the contemporary Olsztyn Lakeland was severely devastated, and under the Treaties of Tilsit, East Prussia was forced to pay high war reparations to France. During the wars with Russia (1812) and France (1813), the region was charged with the excruciating responsibility of feeding the army (Sikorski and Szostakowski 1981).

In 1815, customs duties were levied on trade between the Masurian Lakeland and Polish territories annexed by Russia. This measure obstructed access to key commodity markets, and it had disastrous consequences for agriculture and crafts (Wakar 1971). The damage inflicted by Napoleonic wars and a series of disasters (crop failures, epidemics) contributed to the crisis in Warmia and Mazury which reached its high point in 1834 and continued until the end of the Franco-Prussian war in 1871 (Jałoszyński 1962).

The introduction of separation policies, which divided land into smaller plots and replaced common land use with individual ownership, created favorable grounds for land drainage schemes. The separation act was enforced in 1821, and it contributed to the development of a modern agricultural system (Jałoszyński 1962). It was a slow process that continued for decades. In the district of Szczytno, the majority of agrarian reforms were introduced after the Spring of Nations (1848), and the process was not completed before 1870. In the Biskupiec district, land division took place at two stages in 1822-1826 and 1843. Before 1822, manorial farms were cultivated in the three-field crop rotation system. There were no access roads to fields, and members of the local community were forced to perform all field work at the same time. Land improvement and crop intensification were not popular concerns. Peasants focused mostly on performing their share of the work at minimal cost and effort (Koryncka 1969). In the area of Olsztyn, land separation schemes were introduced in 1830-1860 (Barczewski 1918). New farmland became highly coveted property, and vast efforts were made to reclaimed idle territories. Forests were decimated, crop rotation schemes were introduced, cattle production was expanded and land reclamation works were carried out (Toeppen 1870, Marchlewski 1903, Koryncka 1969). Contrary to their initial purpose, the agrarian reforms of the first half of the 19<sup>th</sup> century significantly deteriorated the situation of small landowners. The landlords preferred their serfs to pay rent rather than provide service, and as a result, impoverished peasants were often forced to donate parts of their land to the lords (Sikorski and Szostakowski 1981). The purchase and requisition of small landowners' property continued until the 1870s (Filipkowski 1983). Thousands of small farms went into the hands

of large landowners who introduced modern farming methods and land reclamation schemes.

The situation in the agricultural sector began to improve only after 1870, although the migration of farm workers to the West created new problems. The construction of railway lines in Olsztyn area opened the region to the world and created access to distant export markets. The first railway section reaching Olsztyn was commissioned for use in 1872, and new lines were built in East Prussia in successive years. The railway section terminating in Czerwonka was opened in 1872, Ostróda – in 1873, Morąg – in 1883, Orneta – in 1884, and Iłowo – in 1887 (Wakar 1971).

By the end of the 19<sup>th</sup> century, land reclamation and lake drainage programs had taken on a more organized form. Water companies were established with the aim of gaining new farmland. In the district of Szczytno, eight water companies were incorporated in 1869-1900, and they assumed control over 14,000 ha of land destined to drainage (Jałoszyński 1962). In the Morąg district, the first water companies were established in 1879, and the initiated land improvement projects were far more comprehensive than those carried out by individual farms. In general, land reclamation schemes were introduced in disregard of the region's hydrological regime, and they led to the complete disappearance of water bodies, including Lakes Niemoj, Naświty, Brzeźno, Skalsze, Steklin Wielki (Phot. 3) and Steklin Mały in the area of Morąg (Wakar 1973). The growing demand for products of animal origin on the German market increased cattle production, and it motivated farmers to expand their land holdings. Between 1849 and 1897, cattle production in East Prussia increased from 600,000 to more than one million head (Filipkowski 1983).

In the interwar period, the Third Reich made numerous efforts to increase agricultural production in East Prussia, the key supplier of food for all of Germany. It was a period of prosperity for large farms (*Ostprussenhilfe*) which were able to intensify their output and expand grassland area with the help of state subsidies. By 1926, pasture area had increased by 25% in comparison with the period before World War I (Affeltowicz 1969). Nevertheless, new problems came to the surface. At the turn of the 19<sup>th</sup> and 20<sup>th</sup> centuries, in particular in the 1920s, East Prussia witnessed massive migration of its rural population to Germany. According to estimates, around one million people, mostly farm workers, emigrated to the Reich between 1871 and 1933. The loss of population was most severely felt in regions where employment rates had already been low, and it resulted in a serious agricultural crisis.

Lake drainage programs were continued after 1900, but to a smaller extent, as demonstrated by maps dating back to the early 20<sup>th</sup> century. According to Barczewski, the lakes of Bartołtowskie, Pudlęskie and Mendryńskie had still existed at the time. The discussed period brought intensified Germanization in the regions of Warmia and Mazury (plebiscite of 1920) due to migration and struggle for land. Land prices rose significantly, spurring new efforts in search of additional cultivation areas.

After World War II, agriculture, including field cultivation, became increasingly mechanized. In many cases, the former land drainage schemes failed to bring permanent results. Meadows and fields continued to be waterlogged, and they were not accessible to tractors and farm machines. In sites drained by a network of open ditches, the existing system could be relatively easily reinstated, but fields drained by means of underground pipelines posed a much bigger problem. Drainage pipes were often laid at a significant depth, and any modifications required the reconstruction of the entire system or mechanical drainage with the involvement of pumping stations. The accumulation of gyttja soils in drained lake basins created additional problems. Gyttja deposits slowed down drainage systems and clogged drainage ditches. Mechanical drainage proved to be problematic in sites where gyttja formations were found under surface peat layers with low bearing capacity. In such areas, excessive drainage can lead to the deterioration of soil parameters (Okruszko 1969). As a result, hundreds of drained locations were left idle in the past decades. According to an inventory of former lakes, only 26 (18%) of them have been preserved in a fully drained condition.

#### **4. The extent of land reclamation in the Olsztyn Lakeland**

The extent of land reclamation efforts in the Olsztyn Lakeland was assessed based on archival and contemporary topographic maps and aerial photographs taken in various periods. The maps developed by Schroetter in 1796-1802 are the oldest cartographic resources which are detailed enough to support the recovery of the former lake network. According to the [www.topmap.pl](http://www.topmap.pl) website, Schroetter's maps are the most accurate source of cartographic information dating back to the turn of the 18<sup>th</sup> and 19<sup>th</sup> centuries. Various editions of Reymann's maps (1806, and the updated version of 1874), Manöverkarte maps (1908) and detailed (1:25 000) German Mestissblätter maps (developed mostly in 1913-1915, but dated to the 1930s to reflect changes in infrastructure development), were also used. On maps dating to the early 20<sup>th</sup> century, many of the drained water bodies are still marked as lakes (Fig. 2, Phot. 2) with a proper name or as "former lakes" (*ehem. ... See*).

Other archival resources have also been analyzed, including "Słownik nazw miejscowych Okręgu Mazurskiego" (Dictionary of Place Names in the Masurian District), compiled by G. Leyding (1959) in the first few years after World War II. Leyding accumulated vast amounts of information relating to the toponymy of north-eastern Poland by collecting data at the source, analyzing old maps and archival documents. In contemporary perspective, Leyding's work is a highly valuable resource of information that is no longer available in archives. His dictionary lists 91 geographic sites termed as former lakes in the Olsztyn Lakeland, including in the Olsztyn district and parts of the neighboring districts (Lidzbark Warmiński, Morąg, Nidzica, Reszel, Ostróda and Szczytno). In this group, 63 sites (69%) were grasslands, 14 (15%) were lakes that had been "mostly drained", which probably implies swampy areas. Individual sites were characterized as swamps, waterlogged meadows or drained lakes.

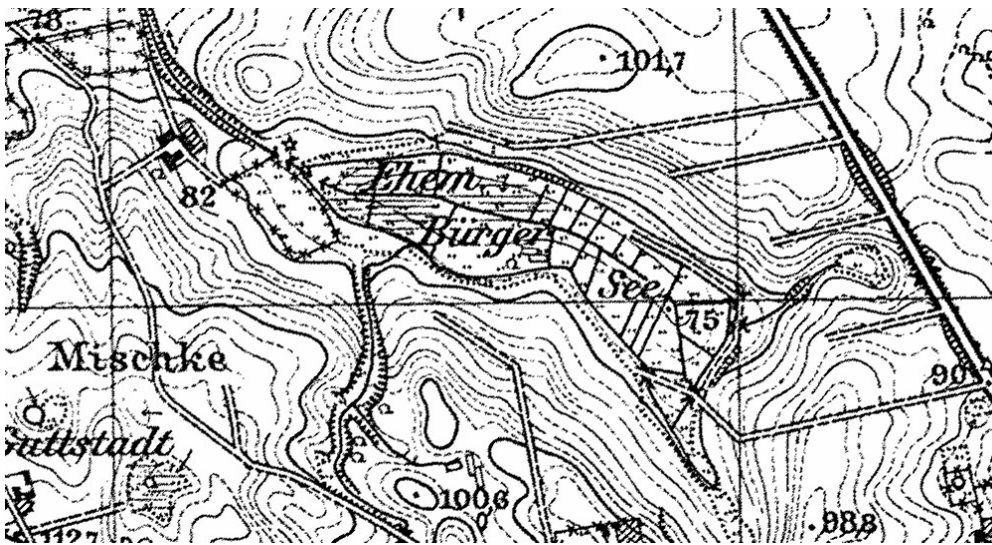


Fig. 2. Drained lakeland area on a map from the early 20<sup>th</sup> century, marked as the "Former Lake Dobromiejskie" (ehemal Bürger See)



Phot. 2. Recent view of partially reinstated, former lake Dobromiejskie (phot. by author)

In "Geografia polskiej Warmii" (Geography of Polish Warmia), father W. Barczewski (1918) cites numerous examples of drained lakes, among them Kiestrój, Duży Świniec, Mały Świniec, Ramsowskie, Dobręskie, Zaginek,



Różnowskie, Marąg, Sętalskie and Krumzy, and he frequently emphasizes the agricultural significance of "lake meadows".

Town charters and chronicles dating back to the 14<sup>th</sup> and 15<sup>th</sup> century (such as *Codex Diplomaticus Warmiensis*) list the names of former lakes in the Olsztyn area, which are also cited by Leyding (1959). Most lake names originated from the Old Prussian and Lithuanian languages (Sieniawski 1878), and some differ completely from their 19<sup>th</sup> or contemporary equivalents. An example of the above is Lake Żegoćkie (presently the Żegoćkie Marshes nature reserve). Referred to as *Siegfriedswalder See* (after the town of Siegfriedswald – Żegoty in Polish) in the 19<sup>th</sup> century, it had been originally known as Pepecten (1305) and Poypote (1358).

The exact dates of land reclamation projects are available for selected sites. For example, Lakes Kiestrój and Bodgańskie were drained during the construction of the Kiermas Canal in 1840-1850 (Barczewski 1918, reference to J. Chłosta), Lake Kalno near Przykop and Nowa Wieś disappeared after the construction of a canal to Lake Łajskie in 1857 (Barczewski 1918), Lake Dymerskie and the adjacent smaller water bodies were drained in 1873 (Jałoszyński 1962), and Lake Fajferek in Olsztyn was drained in 1882 (Wakar 1971).

The majority of land reclamation efforts were made in the late 19<sup>th</sup> century. Few projects of the type were undertaken in the first half of the 19<sup>th</sup> century, as noted by Haffer (1860) who observes that lake drainage "*is an issue of least concern in industrial development*" (in original: „*osuszanie jezior należy do przedmiotów najmniej opracowanych w przemyśle gospodarczym*”). When in 1846, Haffer was vested with the task of shallowing lake valleys in the region of Mazury, "*he was unable to find any literature to support the undertaking, and he was charged with the responsibility of developing the relevant principles and tools as practical guidelines for the required effort*" (in original: „*autor (...) nie znalazł w literaturze prawie żadnego wsparcia, sam przeto sobie musiał tworzyć potrzebne zasady i wynaleźć narzędzia w celu podania instrukcji technikom przywołanym*”). Similar conclusions can be drawn from the available historical resources and archival cartographic materials. Okruszko (1969) observed that the majority of lake drainage projects, hydraulic engineering (canal construction) and land reclamation works were carried out in the 19<sup>th</sup> century. Historical records of various parts of the Olsztyn Lakeland testify to the above (Jałoszyński 1962, Koryncka 1969, Wakar 1971, 1973, 1976). Land reclamation and lake drainage works were a direct consequence of the ordinances issued by Frederick William IV of Prussia: the decree on the use of private rivers of 1843, and the decree on cancellation proceedings and preclusive time limits for drainage projects of 1846 (Toeppen 1870).

In an attempt to recreate the location of former lakes, historical maps were processed, and the identified water bodies were transferred to a contemporary base map. An analysis of lake drainage projects revealed that a total of 143 water bodies with a surface area larger than 1 ha had been completely drained in the Olsztyn Lakeland (Fig. 3).

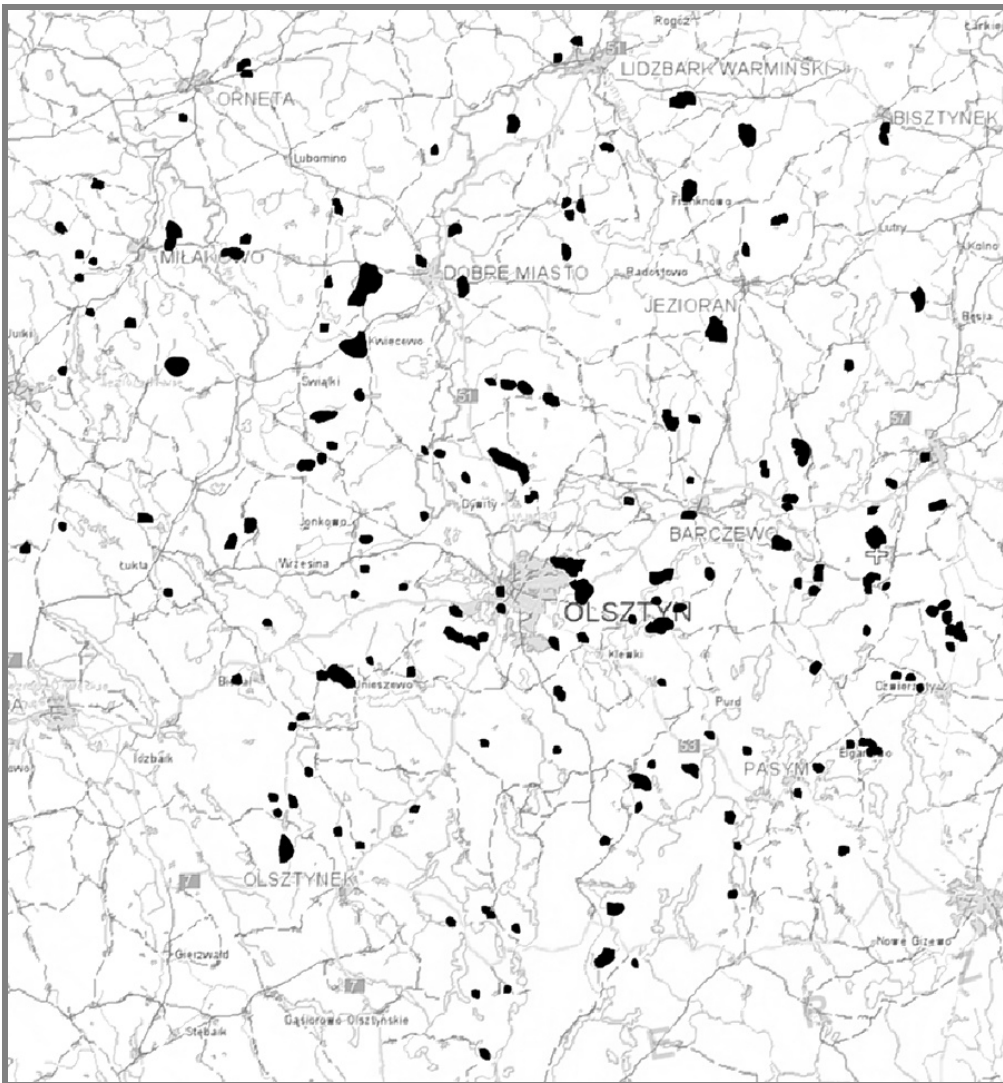


Fig. 3. Water bodies on Schroetter's map (1796-1802) which were not identified on the Mestissblatter map of 1914 (source: own study)

Around four lakes per 100 km<sup>2</sup> had disappeared from the Olsztyn Lakeland. If we consider that there are around 300 lakes in the region today (Lossow 1996), this was a substantial loss (more than 30%). The total area of drained lakes has been estimated at 3000 ha.

Land reclamation works in the Olsztyn Lakeland probably led to the disappearance of more than 143 lakes. According to maps dating back to the early 20<sup>th</sup> century, contemporary topographic data and land cover classifications,

the discussed region could have abounded in many more lakes. However, only those water bodies which had been shown on 19<sup>th</sup> century maps or had been described in historical resources were included in inventories, such as:

- Lake Motek in Olsztyn, situated east of Lake Ukiel along the Kortówka River. It was mentioned by Leyding (1959), and it was identified in the proximity of a formerly drained water body on the Mestissblatter map, but it could not be traced in older cartographic resources. We can assume that water had accumulated in this location during the construction the Olsztyn-Ostróda railway line, which was commissioned for use in 1873;
- Lake Karaśnik in Jabłońskie Lasy, south of Rapaty, was identified as a former lake by Leyding (1959). The discussed basin has the features characteristic of a former lake, but it was probably omitted on maps due to its remote location in the middle of a forest and a small surface area (around 4 ha). Lake Karaśnik could have been a disappearing water body already in the 17<sup>th</sup> century;
- Lake Unikowskie near Unikowo, referred to as Lake Knogsztyń (Knogstin 1357, Knogstein 1382) in the historical resources cited by Leyding (1959). It was not identified on historical maps, and similarly to the lake in Ustnik, it could have been drained before 1800.

## 5. Examples of transformed lakes

For technical reasons, only shallow lakes were drained in the Olsztyn Lakeland, and most of them were water bodies with a small surface area. In the group of 143 inventoried sites, nearly 60% were listed on Schroetter's map as water bodies smaller than 10 ha. Only five drained lakes had an area larger than 100 ha. The largest lakes that had been drained in the Olsztyn Lakeland are:

- Sawąg (Łęgnowskie), situated 3 km west of Dobre Miasto, with an area of 215 ha on Schroetter's map (Sch.) and 231 ha on Reymann's map (R.), partially restored (Phot. 4);
- Kwiecewskie, south-west of Kwiecewo, municipality of Świątki - 129 ha (Sch.) and 156 ha (R.), partially restored, part of a nature reserve (Phot. 5);
- Liznowskie (Klebarskie Małe), situated 1 km east of Olsztyn near Klebark Mały - 104 ha (Sch.) and 115 ha (R.), presently a swampy area (Phot. 6);
- Maręgi (Marąg), situated between Uniszewo and Peglity, 12 km south-west of Olsztyn – 102 ha (Sch.) and 110 ha (R.), nearly entirely reinstated, transformed into a fish pond;
- Brzeźno, east of Boguchwały, municipality of Miłakowo – 101 ha (Sch.) and 116 ha (R.), partially drained, presently a peatland;
- Krokowskie, situated near Krokowo, 3 km south-west of Jeziorany – 97 ha (Sch.) and 104 ha (R.), completely drained, presently a grassland (Phot. 7);
- Różnowskie, situated near Różnowo, 6 km north of Olsztyn – 95 ha (Sch.) and 111 ha (R.), has a working drainage system that supports the agricultural use of drained meadows.

In the successive edition of Reymann's map (ca. 1874), the above water bodies are presented as drained lakes.

A highly characteristic example of a large, drained lake can be found east of the Biskupiec-Dźwierzuty line, outside the Olsztyn Lakeland. Presently known as Dymerskie Meadows, the site occupies the former Lake Dymerskie which, according to Schroetter's map, had a total area of 388 ha at the beginning of the 19<sup>th</sup> century (Fig. 4).



Fig. 4. Lake Dymerskie and other water bodies (lakes: Płociczno, Czarne, Gisielskie i Szczepankowskie), that were drained during the construction of the Dymerski Canal, as shown on Schroetter's map (left), and the same area converted to grasslands, as shown on a map from the beginning of 20<sup>th</sup> century (right)

The efforts to drain Lake Dymerskie began in 1873 upon the creation of the Dymerskie Land Reclamation Task Force (Jałoszyński 1962). The lake was emptied, and the western arm of the Dymerski Canal drained five other lakes (Fig. 4) near Rummy and Szczepankowo (surface area according to Schroetter's map): Gisielskie (18 ha), Szczepankowskie (11 ha), Czarne (19 ha), Płociczno (14 ha) and Kałoj (15 ha). The presence of meadows in drained lake sites was also reported by Orłowicz (1923) in "Ilustrowany przewodnik po Mazurach Pruskich i Warmii" (Illustrated guide to Prussian Mazury and Warmia).



Phot. 3-5. Examples of drained lakes in the Olsztyn Lakeland (phot. by author)

3 – inlet of an underground canal draining the basin of former Lake Steklin Wielki

4 – partially restored Lake Sawag, southern section

5 – Lake Kwiecewskie, converted into a polder with a pumping station



Phot. 6-8. Examples of drained lakes in the Olsztyn Lakeland (phot. by author)

6 – wetland, former Lake Liznowskie

7 – meadows in the drained basin of Lake Krokowskie

8 – Ustnik Nature Reserve

Only a handful of drained lakes in the Olsztyn Lakeland receive legal protection today. Many of them are degraded ecosystems of low natural value. Several sites are characterized by outstanding natural attributes which make them eligible for statutory protection in the form of nature reserves or ecological sites. To date, five locations have been turned into nature reserves (Fig. 5):

1. Zabrodzie – situated in the municipality of Biskupiec (53°49'54" N, 20°58'10" E), created in 1972 with the aim of protecting valuable shrub birch (*Betula humilis*) communities and fragments of a marshy coniferous forest preserved in natural condition (Walczak et al. 2001). The reserve has an area of 23.7 ha. On maps dating back to the early 20<sup>th</sup> century, it was identified as Lake Pudłęskie (Leyding 1959), which was subsequently drained by a ditch feeding into the Dymy Canal;
2. Ustnik – situated in the village of Ustnik, around 3 km north-west of Jeziorany (53°59'45" N, 20°41'54" E). This fauna reserve with an area of 32.5 ha was established to protect the breeding sites of water and marsh birds (Walczak et al. 2001). It is not listed as a lake on any of the analyzed archival maps, and it was probably drained before 1800. The site was identified as a wetland on a topographic map dating back to the 1980s, but stratigraphic studies have confirmed that it had originated from a lake (Lemkowska et al. 2010). The former lake has been partially restored (Phot. 8), today its open water area is estimated at 11 ha, excluding the area covered by rush vegetation;
3. Nadrowskie Swamp – a fauna reserve in the municipality of Olsztynek (53°31'48" N, 20°21'41" E), established in 1991 to preserve the European pond turtle population, herpetofauna habitats, water and marsh bird habitats (<http://olsztyn.rdos.gov.pl>). The reserve has an area of 51.81 ha, and it encompasses the former Lake Nadrowskie (on early 19<sup>th</sup> century maps, the lake had an estimated area of 15 ha, it was drained and renamed to Nadrowskie Meadows) (Leyding 1959), the adjacent marshes and woods. The lake has been partially restored, and today it has an open water area of approximately 10 ha;
4. Żegoćkie Marshes – a fauna reserve in the municipality of Kiwity, north of the village Żegoty (54°2'37" N, 20°41'9" E). It was created in 1991 with the aim of protecting the habitats of nesting and migrating water and marsh birds as well as natural non-forest plant communities (<http://olsztyn.rdos.gov.pl>). The reserve has an area of 33.63 ha, and it covers the central part of Lake Żegoćkie which was drained in the mid 19<sup>th</sup> century and converted into meadows (Leyding 1959). According to archival maps, the former lake had an area of 55 ha. It was drained to the Symsarna River by a system of underground canals and open ditches. Today, it is a wetland overgrown with rushes, with small-sized openwater patches (around 2 ha);
5. Kwiecewo – a nature reserve situated south of the village of Kwiecewo in the municipality of Świątki (53°56'12" N, 20°18'41" E). It was created in 2009 in a former ecological site to protect the breeding sites and habitats of numerous water and marsh bird species (<http://olsztyn.rdos.gov.pl>).

The reserve covers 110 ha of wetlands. The size of open water patches varies subject to water damming levels which are controlled by a pumping station that dumps water to the initial section of the Kwiela River, a left tributary of Łyna. According to archival sources, Lake Kwiecewski had an area of around 150 ha, and it was drained in the mid 19<sup>th</sup> century. In recent years, the site has become a source of conflict between private owners who want to drain the area and use it as grasslands, and environmental activists (Polish Society for Bird Protection) who insist on maintaining an elevated water-table (<http://ratujkwiecewo.pl>).

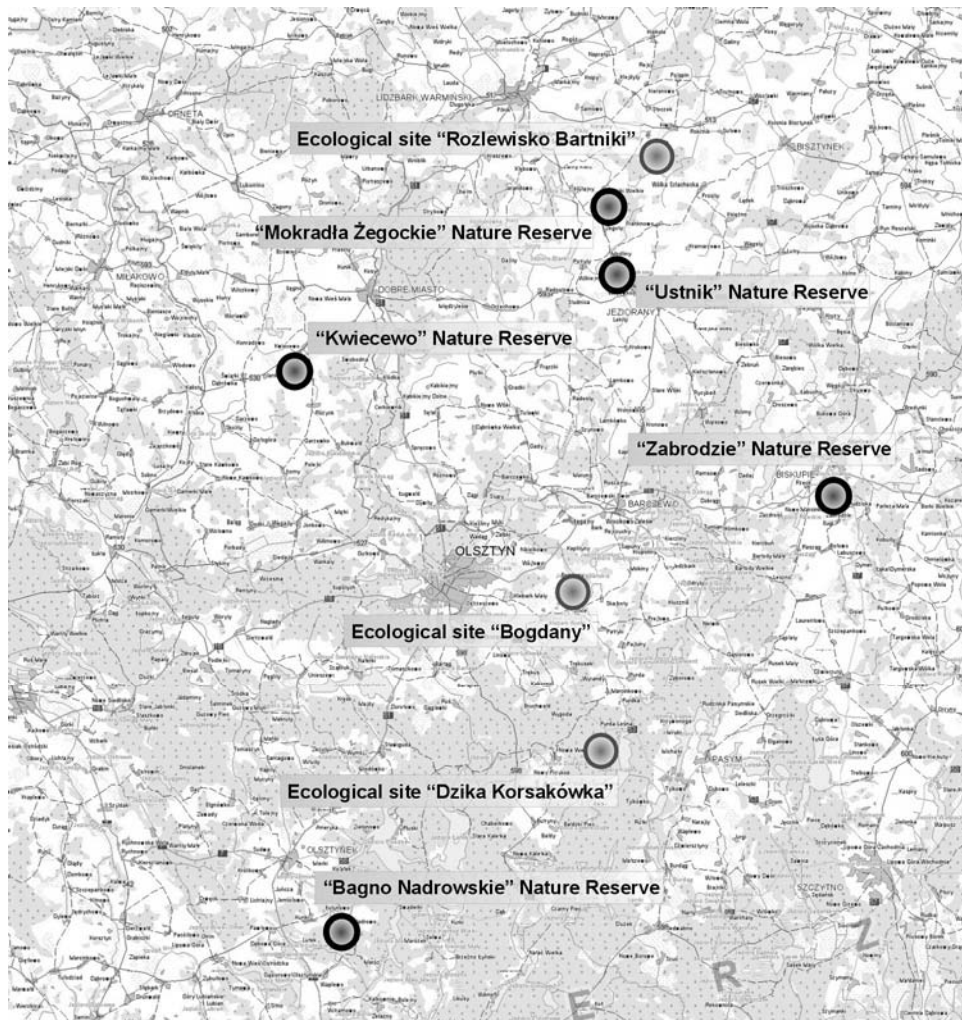


Fig. 5. Nature reserves and ecological sites in the basins of former lakes that were drained in the 19<sup>th</sup> century in the Olsztyn Lakeland



In the group of drained lakes, four are situated within ecological sites (Fig. 5):

1. Bogdany – an ecological site with an area of 196 ha, situated in the municipalities of Purda and Barczewo. It was established in 2009 to preserve the biodiversity of marshes and aquatic ecosystems (<http://olsztyn.rdos.gov.pl>), including the breeding and feeding grounds of numerous birds, and it encompasses the territories stretching along the Kiermas Canal built in 1840-1850. The site features two lakes that were drained during canal construction: Lake Bogdańskie ( $53^{\circ}46'57''$  N,  $20^{\circ}58'32''$  E) - partially restored, with an open water area of 20 ha (a total area of 61 ha on Schroetter's map of 1802), and Lake Kiestrój ( $53^{\circ}45'53''$  N,  $20^{\circ}38'13''$  E) – presently a wetland overgrown with rush vegetation (Phot. 9), with an open water area of 3 ha (on historical maps, a lake with a total area of 7.5 ha);



Phot. 9. Recent state of former lake Kiestrój (phot. by author)

2. Dzika Korsakówka – an ecological site with an area of 27.59 ha, situated in a wooded area in the municipality of Purda, on the western side of Lake Kośno ( $53^{\circ}39'20''$  N,  $20^{\circ}40'28''$  E). It is the remnant of a former lake known as Mędryński Pond (Leyding 1959). It ceased to be an open body of water already in the interwar period, and Barczewski (1918) referred to it as Lake Mendryńskie. On archival maps, it is shown as a mill pond with an area of 30 ha, which still existed in the early 20<sup>th</sup> century. On 19<sup>th</sup> century maps of the area, however, the mill is situated on a stream below the lake, and the presence of a crosscut canal on the Mestissblatter map (1914) suggests that a natural lake had once existed there;

3. Bartniki Floodplain – a valuable bird habitat in the municipality of Kiwity, south of the settlement of Bartniki (54°4'40" N, 20°44'58" E), with an area of 91.8 ha. The floodplain (of which approximately 45 ha is an open water area free of rush vegetation) is a part of the restored Lake Ałowy, first mentioned in 1355 as Lake Ałowe (Leyding 1959). On maps dating back to the early 19<sup>th</sup> century, the lake spanned an area of 71 ha. In the late 19<sup>th</sup> century, it was drained by a system of ditches into the Pisa River, and renamed to Bartnickie Meadows.

## 6. Conclusions

An overview of land reclamation projects in the Olsztyn Lakeland indicates that lake drainage measures were carried out on a large scale in the discussed region. Archival materials gathered and processed for the needs of this study show that the transformations that took place in the lake system in the 19<sup>th</sup> and the early 20<sup>th</sup> century remain poorly investigated, and they constitute a blank page in the history of changes in the geographical environment of the Olsztyn Lakeland. Historical resources discuss individual sites only, and they testify to lack of knowledge about the dramatic changes that had occurred in the past. The users of restored lakes are often unaware that those water bodies ceased to exist for several decades or even a century.

Some of the drained lakes were restored as part of a premeditated effort, whereas others were refilled with water in a natural way. A total of 27 such water bodies were determined in the Olsztyn Lakeland, accounting for 19% of all lakes that had been drained in the past, among them Lake Nowe Włóki (Skwierawski 2006). Water bodies of the type are rarely found in lake atlases or databases of the Institute of Inland Fisheries. Restored lakes have not been surveyed with the use of morphometric techniques because they were non-existent when such data were being gathered. Many have not been provided with contemporary geographic names, and they can be traced only on old maps or in historical papers, such as that developed by Leyding (1959). As a transitory form between natural shallow lakes (prior to drainage) and artificial retention reservoirs (recreated by damming the runoffs), they constitute valuable objects of study. They generally differ from dams in that they allow for a smaller degree of water exchange. Unlike lakes, they for long periods of time had no open water surfaces that would modify bottom deposits, transforming them into waterlogged meadows. In restored water bodies, those habitats become the top deposit layer which can significantly influence the local ecosystem.

Due to an unsupportive hydrological regime (an excessive moisture content), not all drained lakes can be used for farming purposes, and their economic role is limited. Such sites have the features of wetland ecosystems, and when drainage systems are not maintained in working order, the former lakes can be naturally refilled with water. There are three types of former lake sites: drained land used in agricultural production, partially restored wetlands and fully restored water

bodies. Each one of them is a unique ecosystem, characterized by different environmental conditions. As weakly researched components of the lakeland environment, former lakes are fascinating objects of study.

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